



**Title of Investigation:**

**"Seeing" the Invisible—Radio Astronomy for the Visually Impaired**

**Principal Investigator:**

**Dr. James Thieman (Code 690)**

**Other In-house Members of Team:**

**Jim Gass (Code 612.4)**

**Other External Collaborators:**

**Richard Flagg (RF Associates), Jim Sky (Radio-Sky Publishers), and Robert Shelton (Johnson Space Center)**

**Initiation Year:**

**FY 2005**

**Aggregate Amount of Funding Authorized in FY 2004 and Earlier Years:**

**None**

**Funding Authorized for FY 2005:**

**\$31,100**

**Actual or Expected Expenditure of FY 2005 Funding:**

**In-house: \$5,600; Contracts: Jim Sky, \$16,000, and Richard Flagg, \$9,500**

**Status of Investigation at End of FY 2005:**

**To be continued in FY 2006, with funds remaining from FY 2005 and \$31,100 in additional DDF funding**

**Expected Completion Date:**

**May 2007**

DDF annual report

**Purpose of Investigation:**

The Radio JOVE project is a hands-on, inquiry-based educational project intended to allow students, teachers, and the general public to learn about radio astronomy by allowing them to build their own radio telescope from an inexpensive kit and/or using remote radio telescopes through the Internet. This DDF was funded to take this project in a new and different direction: offering astronomy experiences to students who are visually impaired or blind. The Radio JOVE equipment, software, and Web site are to be adapted for use by the blind. The intent is to inspire the blind to understand that astronomy is not a field that is closed to them.

**Accomplishments to Date:**

The first half-year of work has been concentrated on investigating hardware and software approaches to adapt Radio JOVE for the blind. The hardware activities included:

- Analyzing the shortcomings of the original Jove radio receiver (Jove I), with respect to serving the visually impaired
- Fabricating and testing an audio amplifier circuit for the Jove II receiver
- Testing a frequency synthesized oscillator for possible use with a Jove II receiver
- Testing a direct digital synthesis oscillator for possible use in a Jove II receiver.
- Designing and testing new filters and frequency-mixing schemes to improve the receiver's dynamic range
- Designing an internal calibrator for Jove II
- Ordering samples of operational amplifiers to replace obsolete audio preamplifier integrated circuits in Jove I, and
- Talking with our blind co-investigator, Robert Shelton, and other technically oriented blind individuals about special features needed by visually impaired observers.

With regard to the Radio JOVE software used for displaying and analyzing radio signals, the following items were done:

- Tested and adopted a speech synthesis engine for incorporation in Radio Jove software
- Performed a survey of schemes that are currently in use for converting graphics to sound
- Established contacts with other sonification researchers
- Produced an initial three-dimensional conversion of spectrograph data into sound
- Updated Radio Jove storm-prediction software for the new observing season and have begun initial tests of a sonified version, and
- Assembled and tested a software-defined radio as part of the investigation into the next generation of Jove receiver. A software-defined radio may prove especially advantageous to blind or deaf participants.

The Radio JOVE Web site was examined with regard to its compliance for disabled individuals and revised according to current guidelines.



**Figure 1.** Posters for “Seeing the Invisible” project and the “Solar System Radio Explorer Kiosk” were displayed side-by-side at the Huntsville Exceptional Needs Workshop.

Papers for Presentation at Professional Society Meetings, Seminars, Symposia:

Plans for the Radio JOVE adaptation were presented in a poster paper at the Exceptional Needs Workshop held in Huntsville, AL, this past summer. The attendees included many with disabilities, as well as educators of special-needs students. Their critiques provided good ideas for further adaptations of the Radio JOVE project. The software planned for a “Solar System Radio Explorer Kiosk,” a closely related project, also was displayed.

#### **Planned Future Work:**

We anticipate that the work will still require a full 2 years to complete, even though our renewal was received halfway through the first year. Consequently, we expect to request a no-cost extension to the period of performance at the end of the second year so that we can complete the needed 2 years of work.

Work will continue in developing the Jove II receiver performing the following steps:

1. A control interface will be incorporated in the Jove II receiver suitable for use by the blind.
2. The audio capability of the Jove I receiver will be improved for Jove II and it also will be modified to better handle strong signals, such as those encountered from the Sun during daytime observing.
3. A calibrated radio noise source will be added to Jove II to simulate Jovian and solar noise burst levels.
4. The receiver manual will be modified to reflect the changes in the Jove II receiver and to make it compliant with standards for use by the blind.

There are three main tasks that need to be completed for the software:

1. Produce a sonified version of Radio Jupiter Pro noise storm prediction software
2. Produce a sonified file reader for Radio-Sky data-collection software, and
3. Produce a sonified file reader for spectrograph data files.

The Web site will continue to be revised according to compliance standards for the disabled.

The Jove II receiver and accompanying software and Web information will be delivered for testing by select blind observers (in the classroom, if possible) and their feedback used to modify the final product.

#### **Key Points Summary:**

**Project's innovative features:** The most important innovative aspect is the possibility of inspiring the blind to pursue careers in astronomy. To do this, we must sonify a receiver so that a blind person could operate it and understand the information that it broadcasts. This latter task is especially not easy for some types of displays, particularly spectrographic. A sonified version would be of great value to both sighted and unsighted people.

**Potential payoff to Goddard/NASA:** Probably the most important payoff to the Goddard Space Flight Center would be to inspire a new group of underserved, disabled individuals to believe that they could do very technical and scientific work in astronomy or related fields. This might even result in inspiring more of these individuals to consider working for NASA. In addition, participants would become more knowledgeable about the importance of science and the things that NASA does for the general public.

**The criteria for success:** The project would be considered a success if a significant number of visually impaired students, either in special or regular schools, became involved in Radio JOVE. The ultimate aim would be to inspire some of these students to pursue careers in science, technology, engineering, and mathematics, and to work for NASA.

**Technical risk factors:** There is risk in whether we can successfully sonify data to the point where the details of the radio signatures are evident to the blind. This is especially difficult for complicated spectrographic data, a common representational form for data display. There also is risk in whether the end product actually inspires the blind and piques their interest in technical undertakings.